Effect of NPK Fertilizer Fortified with Crop Residues on the Performance of Maize

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Abstract
Field experiment was conducted in two cropping seasons (March and September, 2011) at the Commercial and Research Farm of the Oyo State College of Agriculture, Igboora on the effect of crop residues parkia biglobosa, maize stover and NPK 15:15:15 fertilizer on growth and yield of maize. The experiments were arranged in a Randomized complete Block Design (RCBD) and (SUWAN-Y) maize variety was used as test crop. There were six treatments replicated three times. The treatments include control (0.0t/ha), Parkia biglobosa residue (15t/ha), maize residue (15t/ha), NPK 15 :15:15 fertilizer, (120kg/ha), NPK 15:15 fertilizer (60kg/ha) +Parkia biglobosa residue (7.5t/ha) and NPK 15:15:15 fertilizer (60kg/ha) +maize residue (7.5t/ha). Data were analyzed with the use of Analysis of variance and the means separated by Duncan Multiple Range Test at 5% level of probability. The result showed that NPK 15:15:15 fertilizer (60kg/ha) +Parkia biglobosa residue (7.5t/ha) significantly (P<0.05) improved the grain yield than others and with 283.24% better than the control. The order of response of most characters considered to the treatments were NPK 15:15:15 fertilizer (60kg/ha)+Parkia biglobosa residue (7.5t/ha) >NPK 15:15:15 fertilizer (120kg/ha) >NPK fertilizer 15:15:15 (60kg/ha) +maize residue (7.5t/ha)>Parkia biglobosa residue (5t/ha)>maize residue (15t/ha) and the control was the least. Maize grain yield obtained by using NPK fertilizer 15:15:15 (120kg/ha) gave higher grain than NPK 15:15:15 fertilizer (60kg/ha) +maize residue (7.5t/ha) while Parkia biglobosa residue (15t/ha) also significantly out-yielded maize treated with maize residue (15 t/ha) and significantly increased (P<0.05) than the use of maize residue (15t/ha) with and the control the least.

Key words: *NPK, maize residue, parkia residue, maize stover.*

Introduction
Maize has high yield potentials in the tropics and as such yield of up to 7.5t/ha can be obtained if the crop is properly managed. Unfortunately, yields are generally below 5t/ha (FAO, 2007) and this had resulted in inadequate supply of maize for various usages. To bridge this gap and sustain high yield, soil must be supplied with adequate nutrients. The introduction of high yielding and fertilizer response varieties of maize gave boost to fertilizer consumption by maize crop. Hence, long term high input agriculture has a strong positive effect in improving agronomic properties of soil (Buol and Stokes, 1997).

Crop residues, are parts of plant left in the field after crops have been harvested and threshed as it is done for cereals. The major disadvantage of incoporation of cereal straw is the immobilization of inorganic N and its adverse effect occurring from N-deficiency. The faster decomposition of crop residue and release of N to soil is possible if they are rated with N-fertilizer and applied during field preparation (Sharma, *et al.*,1998). Also, plant residues with high chemical potential will provide positive effects on soil and crops. The crop yield enhancing potentials of this indigenous tree specie (*Parkia biglobosa)* which , are prominent in savanna and maintained by farmers on farms and homesteads as source of soil organic amendment are yet to be fully explored (Tarfa, *et al*., 2004). Findings have also showed that biomass production by the tree is about 8-10t/ha annually (Tarfa, *et al*., 2004). The recycling of crop residues has the advantage of converting the surplus farm waste into useful products for meeting nutrient requirements of crops (Krishna *et al.,* 2004). The residue also maintains the soil physical and chemical conditions and thus improves the overall ecological balance of the crop production system (Powel and Unger, 1997). The use of farm residues when compared with inorganic fertilizer would be cheaper, readily affordable and sustainable. However, high cost, scarcity of resources, nutrient imbalance and soil acidity are problems associated with the use of mineral fertilizer while bulkiness, low nutrient quality and late mineralization are the bottle neck to the sole use of organic manures for crop production in the tropics (Ayeni, 2010). Some studies, confirmed that combined application of organic manures and mineral fertilizer gave superior effects in terms of balanced plant nutrition and also improved soil fertility (Bello and Teka, 2008, Ojeniyi (2011) and Oke, *et al*., 2012). The main benefit of using combined application of organic and inorganic fertilizers, is that, it reduces the amount of for mineral required fertilizer and aids timely mineralization of nutrients from organic manures (Ayeni, 2010).

The chemical composition and the extent to which these residues increase the efficiency of applied inorganic fertilizers and enhance the potentials of the soil to support increased maize production have not been fully exploited. The present study was, therefore, conducted to evaluate the response of maize to the application of crop residues and NPK fertilizer.

Material and Methods

Field experiments was conducted in two cropping seasons (March and September, 2011) at the research farm of the Oyo state college of Agriculture, Igboora the effects of crop residues management (*Parkia biglobosa*), maize stover (mr) and NPK 15:15:15 fertilizer (Nfert) on growth and yield of maize. Igbo-Ora, is in Ibarapa Central Local Government Area derived Savannah Zone of Oyo State. The region has two rainy periods and has between 1000 to 1600mm of rainfall per annum and temperature between 22ºC and 38ºC. (Bimodal pattern of April/May- July and Sept- Dec. with August break).The test crop, SUWAN yellow maize variety was obtained from Oyo State Agricultural Development Programme (OYSADEP) store in Oyo town.

The soil of the experimental site was randomly sampled at depth 0-30cm before planting using soil auger. The soil samples were bulked, air-dried and sieved through 2mm mesh before physic-chemical analysis was carried out before planting.The parameter that was measured includes the pH taken in a 1:25 solution of 10g air-dried soil + 25ml distilled water or 1m KCl solution. Texture was determined by the pipette method. Samples were fractionated using Vanlauwe *et al.,* (1998) method. Olsen-P was measured to determine the available Phosphorus. Percentage total nitrogen was measured by the Kjeldahl digestion method while the Amato method was used to measure the percentage total soil carbon (Amato, 1983). The experiment was laid out in a randomized complete block design (RCBD) with three replicates, each plot size being 3 x3m. The treatments consisted of control (0.0t/ha), *Parkia biglobosa* (15t/ha), maize residue (15t/ha), NPK (120kg/ha), NPK fertilizer (60kg/ha) +parkia biglobosa (7.5t/ha) and Nfert.(60kg/ha) +maize residue (7.5t/ha). The sole organic fertilizers were applied a week before planting while NPK 15:15:15 was applied two weeks after planting respectively. The plots were weeded manually at four and eight weeks after planting throughout the experimental period. Maize growth parameters determined at 4-10WAP were plant height (cm) that was taken with the use metre rule, number of leaves by counting, leaf area (cm^2) using metre rule for length and breadth multiply by 0.75 while the stem girth (cm) was taken with thread and measured on rule.. Maize was harvested at 14WAP and was sun-dried to 12% moisture content before shelled to grains. The yield and yield evaluated were weight of grains, number of seeds per cob, cob weight and cob diameter.

Data were subjected to analysis of variance (ANOVA) procedure was used to evaluate the treatment effects. Mean separated using Duncan multiple range test (DMRT) at 5% level of probability.

Result and discussion

Table 1: Pre- planting physical and chemical properties of soil at the experimental site

Parameter	Value
PH	6.76
Organic matter	1.56%
Total Nitrogen	0.11%
Available P	16.9cmg/kg
Exchangeable K	1.14cmol/kg)
Calcium	0.16cmol/kg
Magnessium	0.38cmol/kg
Physical particle size	
Sand	78.4%
Silt	11.6%
Clay	10.0%

Table 1 shows the chemical and physical properties of the soil used. The soil is moderately acidic and with low organic matter content. The total N and Ca value is below the critical level of 0.2% while the K status fell above the critical level of 0.2cmol/kg (Adeoye, 1993). The available P, K and Mg all fell within critical range. The lower values of organic matter, N% and Ca justify the need for nutrient application.

Table 2: Proximate analysis of crop residues

Element	*Parkia biglobosa* residue	Maize residue
TN%	2.76	00.06
Average Phosphorus(cmol/kg)	1.13	0.18
K(cmol/kg)	72.73	0.22
Ca (cmol/kg)	6.07	0.81
Mg (cmol/kg)	0.58	0.31

Table 2, *Parkia biglobosa* residue was generally high in all major nutrients compared with maize residue. The N% indicated that *parkia* quality is better than maize waste and considering the magnitude of the essential nutrients in these residues, it can be deduced that the crop residues have potentials sources for soil amendments but with varying degrees among the residues.

Table 3: Effect of crop residues and NPK fertilizer on height of maize

	leaf area (cm^2) Weeks after planting				height (cm) Weeks after planting			
Treatment	4	6	8	10	4	6	8	10
Control	ns	350.46c	379.30c	393.92b	86.00d	110.00c	166.73D	178.27c
Maize residue (15t/ha)	ns	390.92bc	420.67bc	427.25ab	103.33c	118.33bc	178.10CD	189.53bc
Parkia *biglobosa*(15t/ha)	ns	427.81abc	442.75abc	496.00ab	109.33c	125.00abc	185.13BCD	192.93bc
NPK (60kg) +*Parkia biglobosa* (7.5t/ha)	ns	527.25a	570.41a	570.41a	123.67a	147.00a	200.87Ab	225.20b
NPK (120kg/ha)	ns	498.91ab	522.45ab	536.73ab	121.67ab	140.00ab	207.17A	210.40ab
NPK(60kg/ha) + maize residue (7.5t/ha)	ns	469.13abc	517.04ab	517.15ab	116.67b	140.00a	195.07Abc	203.13ab

Means followed by the same letters in the same columns and rows are not significantly different at 5% level of probability by DMRT

Result from Table 3 shows the comparative effect of various treatments of organo-mineral fertilizers on agronomic characters of maize. The application of the organo-mineral fertilizers significantly improved all the growth characters considered. There were significant increments in the plant height throughout the growing period and between the treatments. At 4, 6 and 8 weeks after planting (WAP) the maize plants were tallest with in plots that received treatments NPK (60kg/ha) +pr (7.5t/ha) than other with treatments throughout the sampling period, with control giving the least value. The results here are in accordance with Akpomujere and Omueti (1991) that has found there is better performance of organic and in-organic fertilizers when combined than when applied as either farmyard manure or in-organic fertilizer alone.

The Table also, shows the comparative effect of various organo-mineral fertilizers on leaf area. Leaf area generally increased with the application of the organo-mineral fertilizers. There were significant difference between treatments with NPK (60kg/ha) +*Parkia biglobosa* (7.5t/ha) treatment having the highest leaf area followed by Nfert. (120kg/ha) at 4,6 and 8 weeks after planting with control having the least value. The lower result from the control supported the findings of Okwuowulu (1995), in which unfertilized plant had lower leaf area due to less number of leaves resulting from pre-mature leaf fall and early vine senescence.

Table 4: Effect of crop residues and NPK fertilizer on girth and number of leaves

	Plant girth (cm) Weeks after planting (WAP)				Number of leaves Weeks after planting (WAP)			
Treatment	4	6	8	10	4	6	8	10
Control	3.40c	3.63e	3.85e	4.26e	Ns	9.67c	10.67c	9.67c
Parkia biglobosa (15t/ha)	4.80b	5.56c	6.79c	7.78c	Ns	10.33BC	11.33bc	11.79C
Maize residue(15t/ha)	4.66b	5.21d	5.39d	6.56d	Ns	10.33BC	11.33BC	11.07c
NPK (120kg/ha)	4.48b	6.45b	7.58b	8.68b	Ns	11.33ab	12.33ab	12.45b
NPK(60kg/ha) + Parkia biglobosa(7.5t/ha)	5.09a	7.58a	8.29a	9.36a	Ns	12.00a	13.00a	14.08a
NPK(60kg/ha) + maize residue(7.5t/ha)	4.65b	5.98bc	7.24bc	8.34bc	Ns	10.67bc	11.67abc	12.08bc

Means followed by the same letters in the same columns and rows are not significantly different at 5% level of probability by DMRT

Table 4 shows that plants with NPK (60kg/ha) + *Parkia biglobosa* (7.5t/ha) had the largest stem girth and markedly performed well when compared with other treatments. Stem girth differed significantly under different treatments. At 4, 6 and 8 weeks after planting, NPK 15:15:15 fertilizer (60kg/ha) + *Parkia biglobosa* residue (7.5t/ha), had the highest stem girth while the control was least. The increase in stem girth with time is a reflection of the retention of appreciable amount of assimilates in the stem for leaf production. The number of leaf per plant also followed the same trend was observed in the other parameters.

Table 5: Effect of crop residues and NPK fertilizer on yield components of maize

Treatment	Cob wt (kg)	Cob diameter (cm)	No of grains/cob	yield kg/ha
Control	0.21d	12.10c	244.00f	1.73d
Parkia biglobosa (15t/ha)	0.34bcd	17.00bc	465.00d	2.53c
Maize residue (15t/ha)	0.26cd	13.67C	426.00E	2.33c
NPK (120kg/ha)	0.49ab	22.50AB	632.00b	5.63b
NPK (60kg/ha) + *Parkia biglobosa* (7.5t/ha)	0.60A	27.33A	676.00a	6.63a
Nfert (60kg/ha) + mr(7.5t/ha)	0.43abc	22.50ab	602.00c	5.43b

Means followed by the same letter in the same columns are not significantly different at 5% level of probability by DMRT.

Table 5 shows the comparative effect of crop residues and NPK fertilizer on maize yield components. Treatment NPK 15:15:15 fertilizer (60kg/ha) + *Parkia biglobosa* residue (7.5t/ha) had the highest number of seeds per cob weight of grains on cob and cob diameter. The results are in line with findings of Adediran et al.,(1999) that organo-mineral fertilizer application enhanced fertilizer use efficiency and with better economic response. It is also in accordance with John *et al.,* (2004) who has observed that an integral use of organic manures and in-organic fertilizers will support the supply of adequate quantities of plant nutrients required to sustain maximum crop production.

The findings are also in consonance with the observations of Oke *et al.,* (2012) who summarized the advantages of combined application of organic and inorganic fertilizers as follows (a) the combination of both organic and inorganic fertilizer may be a more cost effective approach. (b) organo-mineral fertilizer (OMF) may serves as a better potential substitute for mineral fertilizers in maize production. While Ojeniyi (2011) further concluded that OMF had liming effect and improved soil organic matter, nutrient content and availability of cations compared with inorganic fertilizer. Hence, combined use of organic and inorganic fertilizers at reduced rates also enhances nutrient uptake.

Conclusion

The use of residues (parkia and maize) alone did not produce optimum grain and growth performance. To obtain high yield the residues would have to be complemented with NPK fertilizer. This study shows that, with respect to shortage and cost of inorganic fertilizers, intensification of maize production can be possible with proper residue management. Thus, residue fortification can be considered as good alternative measures to sole application of either organic or inorganic fertilizer. Generally, most parameters evaluated in this study showed that it was advantageous to grow maize with combined use of organic and inorganic fertilizer for maximum production. Hence, farmer should consider the fortification of NPK fertilizer and residue especially incorporation of leguminous crops in the farming system as a means of ameliorating the fertility status of the soil for optimum production.

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